First Responder Guide
For
Space Object Re-Entry

February 18, 2008 Revised

FEMA

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Information for the Public

A United States satellite is falling back to earth and could potentially impact almost anywhere on the planet.

The satellite has hazardous materials on board that could pose immediate hazards to people if they come in contact with the material.

Specifically, the satellite contains fuel and metal containers that are considered hazardous materials and could survive entry intact.

Any debris should be considered potentially hazardous, and should not be touched, handled, or moved.

Citizens who observe or encounter falling debris should notify your local public safety agency and stay away from it.

Information for First Responders

The satellite that is degrading from orbit has hazardous materials on board that could pose immediate hazards to people if they come in contact with the material.

The craft contains fuel and specialized containers that are considered hazardous materials and could survive entry intact.

Any debris should be considered potentially hazardous, and first responders should not attempt to pick it up or move it.

First responders should secure a perimeter and control access around any debris. DO NOT pick up any debris. Notify your local emergency manager of its location immediately.

The concerns are similar to those encountered after the space shuttle Columbia entered the atmosphere. However, this craft has far less hazardous materials and is much smaller in size.

The following information about the two hazardous materials of concern is provided for first responders.

Hydrazine, anhydrous

US Department of Transportation
Emergency Response Guidebook (ERG) 2004
ERG Guide 132
ERG ID Number 2029

Potential Hazards

Fire or Explosion

- Flammable/combustible materials.
- May be ignited by heat, sparks or flames.
- Vapors may form explosive mixtures with air.
- Vapors may travel to source of ignition and create flashback.
- Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks).
- Vapor explosion hazard indoors, outdoors, or in sewers.
- Those substances designated with a "P" may polymerize explosively when heated or involved in a fire.
- Runoff to sewer may create fire or explosion hazard.
- Containers may explode when heated.
- Many liquids are lighter than water.

Health

- May cause toxic effects if inhaled or ingested/swallowed.
- Contact with substance may cause severe burns to skin and eyes.
- Fire will produce irritating, corrosive and/or toxic gases.
- Vapors may cause dizziness or suffocation.
- Runoff from fire control or dilution water may cause pollution.

Public Safety

- As an immediate precautionary measure, isolate spill or leak area for at least 50 meters (150 feet) in all directions.
- Keep unauthorized personnel away.
- Stay upwind.
- Keep out of low areas.

- Ventilate closed spaces before entering.

Protective Clothing

- Wear positive pressure Self Contained Breathing Apparatus (SCBA).
- Wear chemical protective clothing that is specific for this product. It may provide little or no thermal protection.
- Structural firefighters' protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations where direct contact with the substance is possible.

Evacuation

- Large Spill
  - See the Table (see DOT ERG) of Initial Isolation and Protective Action Distances for highlighted substances. For non-highlighted substances, increase in the downwind direction, as necessary, the isolation distance shown under “PUBLIC SAFETY”
- Fire
  - If the tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (0.5 miles) in all directions. Also, consider initial evacuation for 800 meters (0.5 miles) in all directions.

Emergency Response

Fire

- Some of these materials may react violently with water.
- Small Fires
  - Dry chemical, carbon dioxide, water spray, or alcohol-resistant foam.
- Large Fires
  - Water spray, fog, or alcohol-resistant foam.
  - Move containers from the fire area if you can do so without risk.
  - Dike fire-control water for later disposal; do not scatter the material.
  - Do not get water inside containers.
- Fire Involving Tanks or Car/Trailer Loads
  - Fight fire from maximum distance or use unmanned hose holders or monitor nozzles.
  - Cool containers with flooding quantities of water until well after fire is out.

- Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank.
- ALWAYS stay away from tanks engulfed in fire.
- For a massive fire, use unmanned hose holders or monitor nozzles. If this is impossible, withdraw from the area and let the fire burn.

Spill or Leak

- Fully encapsulating, vapor-protective clothing should be worn for spills and leaks with no fire.
- ELIMINATE all ignition sources (no smoking, flares, sparks, or flames in immediate area).
- All equipment used when handling the product must be grounded.
- Do not touch or walk through spilled material.
- Stop the leak if you can do it without risk.
- Prevent entry into waterways, sewers, basements, or confined areas.
- A vapor-suppressing foam may be used to reduce vapors.
- Use clean non-sparking tools to collect absorbed material.

Large Spills

- Dike far ahead of the liquid spill for later disposal.
- Water spray may reduce vapor but may not prevent ignition in closed spaces.

First Aid

- Move victim to fresh air.
- Call 9-1-1 or emergency medical services.
- Give artificial respiration if the victim is not breathing.
- **Do not use mouth-to-mouth method if the victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.**
- Administer oxygen if breathing is difficult.
- Remove and isolate contaminated clothing and shoes.
- In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes.
- In case of burns, immediately cool affected skin for as long as possible with cold water. Do not remove clothing if adhering to skin.
- Keep victim warm and quiet.

- Effects of exposure (inhalation, ingestion, or skin contact) to substance may be delayed.
- Ensure that medical personnel are aware of the materials involved and take precautions to protect themselves.

Hydrazine (Expanded Information)

US Department Health and Human Services/National Institutes of Health (HHS/NIH)
US National Library of Medicine
Wireless Information System for Emergency Responders (WISER)
(http://webwiser.nlm.nih.gov/updateProfile.do)

Identification and Hazards

- **CAS:**
  302-01-2
  UN/NA:
  2029
  2030
  3293
  STCC:
  49 062 25
  49 350 30
- Handle as a CARCINOGEN—WITH EXTREME CAUTION
- HIGHLY CORROSIVE; can cause severe eye and skin irritation
- FLAMMABLE and REACTIVE; DANGEROUS FIRE and EXPLOSION HAZARD
- FIRE PRODUCES POISONOUS GASES
- CONTAINERS MAY EXPLODE IN FIRE
- Extinguish fire with dry chemical, carbon dioxide or water spray
- Beware of flashback from vapors

Limits

- OSHA Permissible Exposure Limit: Table Z-1 8-hr Time-Weighted Avg: 1 ppm (1.3 mg/cu m). Skin Designation. Vacated 1989 OSHA PEL TWA 0.1 ppm (0.1 mg/cu m), skin designation, is still enforced in some states.
- ACGIH 8 hr Time Weighted Avg (TWA): 0.01 ppm, skin ,A3; Confirmed animal carcinogen with unknown relevance to humans. Excursion Limit Recommendation: Excursions in worker exposure levels may exceed three times the TLV-TWA for no more than a total of 30 min during a work day, and under no circumstances should they exceed five times the TLV-TWA, provided that the TLV-TWA is not exceeded.
- Immediately Dangerous to Life or Health IDLH - 50 ppm; NIOSH considers hydrazine to be a potential occupational carcinogen.

DOT Hazard Classifications

Class 3 - Flammable liquids (and Combustible liquids [U.S.])
Class 6 - Toxic substances and Infectious substances
Class 8 - Corrosive substances
Division 6.1 - Toxic substances

Additional Information

NFPA704-Health	4 – Extreme
NFPA704-Flammability	4 – Extreme
NFPA704-Instability	3 – Severe/Serious
NFPA704-Special Hazards	Not Applicable

Fire Fighting Procedures

- Hydrazine vapor is exceptionally hazardous in that once it is ignited it will continue to burn by exothermic decomposition in complete absence of air or other oxidant.
- Flammable liquid - Flammable over a wide range including 100% pure material. Air or oxygen is not required for decomposition. Closed containers may rupture violently when heated. Thermally unstable. Ignites in air at room temperature on metal oxide surfaces, & in a wide variety of porous materials, such as cellulosic materials.
- Lower flammable limit: 2.9% by volume; Upper flammable limit: 98% by volume
- Explodes during distillation if traces of air are present, also affected by UV and metal ion catalysts.
- The decomposition reaction may be explosive, especially when catalysed by certain metals and metal oxides.

If the material is on fire or involved in a fire:

- Extinguish the fire using an agent suitable for the type of fire. (Material itself does not burn or burns with difficulty.)
- Keep runoff water out of sewers and water sources.
- Do not extinguish the fire unless flow can be stopped.
- Use water in flooding quantities as fog.
- Cool all affected containers with flooding quantities of water.
- Apply water from as far a distance as possible.
- Solid streams of water may be ineffective. Use “alcohol” foam, dry chemical, or carbon dioxide.
- Hydrazine can ignite spontaneously in air, when in contact with porous materials

Protective Equipment/Clothing

The following are recommendations for personal protective equipment (PPE) and decontamination, at any detectable concentration, when concentrations are above the

National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit (REL) or where there is no REL (Assigned protection factor = 10,000**):**

- Any self-contained breathing apparatus (SCBA) that has a full face piece and is operated in a pressure-demand or other positive-pressure mode should be considered (Assigned protection factor = 10,000).
- Any supplied-air respirator that has a full face piece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus should be considered.
- Any appropriate escape-type, SCBA should be considered.
- Wear appropriate personal protective clothing to prevent skin contact**.**
- Teams performing mitigation or assessment should use Level A suit.
- Wear appropriate eye protection to prevent eye contact.
- Eyewash fountains should be provided in areas where there is any possibility that workers could be exposed to the substance; this is irrespective of the recommendation involving the wearing of eye protection.
- Facilities for quickly drenching the body should be provided within the immediate work area for emergency use where there is a possibility of exposure.
    - Note: It is intended that these facilities provide a sufficient quantity or flow of water to quickly remove the substance from any body areas likely to be exposed. The actual determination of what constitutes an adequate quick drench facility depends on the specific circumstances. In certain instances, a deluge shower should be readily available; whereas, in others, the availability of water from a sink or hose could be considered adequate.
- Vinyl-coated hand protection, natural or reclaimed rubber protection, rubber aprons, and plastic eye and face protection should be used when working with small quantities.
- Where the possibility of gross splashing exists, full protective clothing made of rubber, neoprene, or vinyl-coated materials should be worn.
- For respiratory protection in situations where recommended tolerance limits are exceeded, respiratory protective equipment should be used.

Symptoms of Exposure

- Neurological
    - Agitation
    - Lowered mental state
    - Unresponsive
    - Headache
    - Lack of coordination

- Spasms/Seizures

- Eyes
  - Dilated pupils
  - Light sensitivity
  - Eye irritation/redness
  - Eye swelling
  - Tearing
  - Impaired vision
  - Vision loss
- Nose
  - Nasal irritation
- Mouth/Throat
  - Mouth irritation
  - Drooling/Salivation
  - Throat irritation
- Cardiovascular
  - Arrhythmia
  - Hypoxia/cyanosis
- Respiratory
  - Irregular breathing
  - Shortness of breath
  - Respiratory burning/irritation
  - Pulmonary edema
  - Hypoxia/Cyanosis
- Gastro/Urinary
  - Nausea
  - Vomiting
  - Vomiting blood
  - Diarrhea
  - Urination, bloody
- Skin
  - Itching
  - Skin burns/burning

- Skin swelling
- Rash
- Skin redness
- Cyanosis/Blue

- NFPA704-Health
  - 4 - Extreme

Exposure Treatment

Oral Exposure

- Do NOT induce emesis (vomiting).
- **Dilution:** Immediately dilute with 4 to 8 ounces (120 to 240 mL) of water or milk (not to exceed 4 ounces/120 mL in a child).
- **Activated Charcoal:** Administer charcoal as a slurry (240 mL water/30 g charcoal). Usual dose: 25 to 100 g in adults/adolescents, 25 to 50 g in children (1 to 12 years), and 1 g/kg in infants less than 1 year old.
- **Gastric Lavage:** Consider after ingestion of a potentially life-threatening amount of poison if it can be performed soon after ingestion (generally within 1 hour). Protect the victim's airway by placing him or her in the Trendelenburg and left lateral decubitus position or by endotracheal intubation. Control any seizures first.
  - **Contraindications:** Loss of airway protective reflexes or decreased level of consciousness in unintubated patients; following ingestion of corrosives; hydrocarbons (high aspiration potential); patients at risk of hemorrhage or gastrointestinal perforation; and trivial or non-toxic ingestion.
- **Seizures:** Administer a benzodiazepine IV; Diazepam (Adult: 5 to 10 mg, repeat every 10 to 15 min as needed. Child: 0.2 to 0.5 mg/kg, repeat every 5 min as needed) or Lorazepam (Adult: 2 to 4 mg; Child: 0.05 to 0.1 mg/kg).
  - Consider phenobarbital if seizures recur after diazepam 30 mg (adults) or 10 mg (children > 5 years).
  - Monitor for hypotension, dysrhythmias, respiratory depression, and need for endotracheal intubation. Evaluate for hypoglycemia, electrolyte disturbances, and hypoxia.
- **Acute Lung Injury:** Maintain ventilation and oxygenation and evaluate with frequent arterial blood gas or pulse oximetry monitoring. Early use of PEEP and mechanical ventilation may be needed.
- **Methemoglobinemia:** Administer 1 to 2 mg/kg of 1% methylene blue slowly IV in symptomatic patients. Additional doses may be required.

- **Pyridoxine may be antidotal.** Dose of pyridoxine is 25 mg/kg, 1/3 given IM and 2/3 given IV over 3 hours. Increase the dose by 25 mg/kg every 5 to 10 minutes to a maximum of 300 mg/kg/dose for continuing symptoms.

Inhalation Exposure

- **Inhalation:** Move the patient to fresh air. Monitor for respiratory distress. If cough or difficulty breathing develops, evaluate for respiratory tract irritation, bronchitis, or pneumonitis. Administer oxygen and assist ventilation as required. Treat bronchospasm with inhaled beta2 agonist and oral or parenteral corticosteroids.
- **Seizures:** Administer a benzodiazepine IV; Diazepam (Adult: 5 to 10 mg, repeat every 10 to 15 min as needed. Child: 0.2 to 0.5 mg/kg, repeat every 5 min as needed) or Lorazepam (Adult: 2 to 4 mg; child: 0.05 to 0.1 mg/kg).
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Eye Exposure

- **Decontamination:** Irrigate exposed eyes with copious amounts of room temperature water for at least 15 minutes. If irritation, pain, swelling, lacrimation, or photophobia persist, the patient should be seen in a healthcare facility.
- Patients symptomatic following exposure should be observed in a controlled setting until all signs and symptoms have fully resolved.
- **Seizures:** Administer a benzodiazepine IV; Diazepam (Adult: 5 to 10 mg, repeat every 10 to 15 min as needed. child: 0.2 to 0.5 mg/kg, repeat every 5 min as needed) or Lorazepam (Adult: 2 to 4 mg; child: 0.05 to 0.1 mg/kg).
    - Consider phenobarbital if seizures recur after diazepam 30 mg (adults) or 10 mg (children > 5 years).
    - Monitor for hypotension, dysrhythmias, respiratory depression, and need for endotracheal intubation. Evaluate for hypoglycemia, electrolyte disturbances, and hypoxia.

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Dermal Exposure

- Hydrazine can SPONTANEOUSLY IGNITE upon contact with cloth; clothing should be removed immediately.
- **Decontamination:** Remove contaminated clothing and wash exposed area thoroughly with soap and water. A physician may need to examine the area if irritation or pain persists.
- Treat dermal irritation or burns with standard topical therapy. Patients developing dermal hypersensitivity reactions may require treatment with systemic or topical corticosteroids or antihistamines.
- **Seizures:** Administer a benzodiazepine IV; Diazepam (Adult: 5 to 10 mg, repeat every 10 to 15 min as needed. Child: 0.2 to 0.5 mg/kg, repeat every 5 min as needed) or Lorazepam (Adult: 2 to 4 mg; child: 0.05 to 0.1 mg/kg).
    - Consider phenobarbital if seizures recur after diazepam 30 mg (adults) or 10 mg (children > 5 years).
    - Monitor for hypotension, dysrhythmias, respiratory depression, and need for endotracheal intubation. Evaluate for hypoglycemia, electrolyte disturbances, hypoxia.
- **Acute Lung Injury:** Maintain ventilation and oxygenation and evaluate with frequent arterial blood gas or pulse oximetry monitoring. Early use of PEEP and mechanical ventilation may be needed.
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EPA Recommended Detection Instrumentation

- Honeywell (Zellweger) SPM - Hydrazine Low Level Key
  http://www.detect-measure.com/manuf_zell.html#SPM
  1-713-541-9800

- Drager detector tube - Hydrazine
  http://www.draeger.com/ST/internet/US/en/index.jsp
  1-800-858-1737

Reactivities and Incompatibilities

Additional Cautions for HazMat Teams

- Residue from dehydrating hydrazine with barium or calcium oxide slowly decomposes exothermically in daylight and finally explodes.
- Explosive metal hydrazides form when hydrazine & alkali metals are mixed in liquid ammonia.
- While boiling a sample of a polyester fiber in hydrazine in a glass beaker, the technician used a somewhat rusty pair of metal tweezers to handle the sample. When the tweezers were put in the solution, the solution ignited. The ignition temperature of hydrazine varies from 75 deg F in the presence of iron oxide to 518 deg F in a glass container.
- During the measurement of shock sensitivity of a mixture containing hydrazine, a drop of the hydrazine mixture fell inadvertently on the tetryl donor explosive. The tetryl immediately burst into flame.
- Oxidizers, hydrogen peroxide, nitric acid, metallic oxides, acids (Note: Can ignite SPONTANEOUSLY on contact with oxidizers or porous materials such as earth, wood, & cloth).
- Hydrazine ignites in contact with chlorine.
- Hydrazine is decomposed explosively by chromates & chromic anhydride.
- Hydrazine reacts vigorously with cupric oxide.
- Spontaneous ignition occurs when /fluorine & hydrazine/ are mixed.
- The catalytic decomposition of hydrazine in the presence of Raney nickel may be vigorous at room temp.
- The blue precipitate formed from nickel perchlorate & hydrazine in water exploded violently when a glass stirring rod was introduced into the suspension.
- Spontaneous ignition occurs when nitrous oxide & lithium hydride or hydrazine are mixed.
- Potassium dichromate or sodium dichromate reacts explosively with hydrazine.
- The action of an ethereal soln of hydrazine on zinc diamide or diethyl zinc, gives a product, zinc hydrazine, which explodes at 70 deg C.

Additional Resources

US National Library of Medicine - Hazardous Substances Data Bank (HSDB); http://toxnet.nlm.nih.gov/

US Environmental Protection Agency (EPA) - Technology Transfer Network Air Toxics Web Site; http://www.epa.gov/ttn/atw/hlthef/hydrazin.html

Department of Health and Human Services Centers for Disease Control and Prevention (CDC); http://emergency.cdc.gov/agent/hydrazine/

New Jersey Department of Health and Senior Services – Hazardous Substance Fact Sheet; http://nj.gov/health/eoh/rtkweb/documents/fs/1006.pdf

US Occupational Safety and Health Administration (OSHA) – Safety and Health Topics;
http://www.osha.gov/dts/chemicalsampling/data/CH_245900.html

Hydrazine (Technical Information)

The National Institute for Occupational Safety and Health
http://www.cdc.gov/niosh/npg/npgname-a.html

NIOSH Publication No. 2005-149: *NIOSH Pocket Guide to Chemical Hazards*	**September 2005**
Hydrazine	**CAS** 302-01-2
H_2NNH_2	**RTECS** MU7175000
Synonyms & Trade Names Diamine, Hydrazine (anhydrous), Hydrazine base	**DOT ID & Guide** 2029 132 (anhydrous) 3293 152 (< or =37% solution) 2030 153 (37-64% solution) 2029 132 (>64% solution)

Exposure Limits	**NIOSH REL**: Ca C 0.03 ppm (0.04 mg/m^3) [2-hour] See Appendix A
	OSHA PEL†: TWA 1 ppm (1.3 mg/m^3) [skin]

IDLH Ca [50 ppm] See: 302012	**Conversion** 1 ppm = 1.31 mg/m^3

Physical Description

Colorless, fuming, oily liquid with an ammonia-like odor. [Note: A solid below 36°F.]

MW: 32.1	BP: 236°F	FRZ: 36°F	Sol: Miscible
VP: 10 mmHg	IP: 8.93 eV		Sp.Gr: 1.01
Fl.P: 99°F	UEL: 98%	LEL: 2.9%	

Class IC Flammable Liquid: Fl.P. at or above 73°F and below 100°F.

Incompatibilities & Reactivities

Oxidizers, hydrogen peroxide, nitric acid, metallic oxides, acids [Note: Can ignite SPONTANEOUSLY on contact with oxidizers or porous materials such as earth, wood & cloth.]

Measurement Methods

NIOSH 3503; OSHA 20, 108
See: NMAM or OSHA Methods

Personal Protection & Sanitation

(See protection)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet (flammable)
Change: No recommendation
Provide: Eyewash, Quick drench

First Aid

(See procedures)
Eye: Irrigate immediately
Skin: Water flush immediately
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations

NIOSH
At concentrations above the NIOSH REL, or where there is no REL, at any detectable concentration:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape: Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes

inhalation, skin absorption, ingestion, skin and/or eye contact

Symptoms

Irritation eyes, skin, nose, throat; temporary blindness; dizziness, nausea; dermatitis; eye, skin burns; in animals: bronchitis, pulmonary edema; liver, kidney damage; convulsions; [potential occupational carcinogen]

Target Organs

Eyes, skin, respiratory system, central nervous system, liver, kidneys

Cancer Site

[in animals: tumors of the lungs, liver, blood vessels & intestine]